

Energy transfer/O-Level

Physical change : no new substance is formed

e.g. melting, boiling, freezing, dissolving

Chemical change : thermal energy transferred during a chemical change. New substance is formed

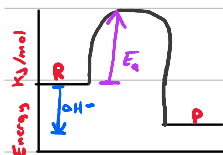
Energy transfer (Enthalpy change ΔH)

Exo thermic reaction

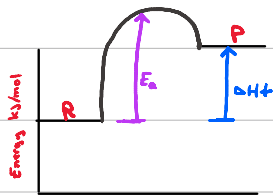
heat is out from system to surrounding

Endo thermic reaction

heat is in from surrounding to system



Activation energy E_a is the minimum energy that colliding particles must have to start the reaction



$$\Delta H = \text{Heat products} - \text{Heat reactants}$$

$$\Delta H = \text{Heat products} - \text{Heat reactants}$$

ΔH is negative

ΔH is positive

examples: combustion



examples: thermal decomposition



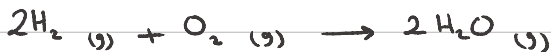
neutralisation:

photosynthesis



Bond energy calculations

energy change (ΔH) can be calculated as bonds broken minus bonds formed, unit: kJ/mol



Bond breaking
in reactants (endo)

Bond making
in products (exo) = ΔH

draw the displayed structures, then count the bonds



$$(2 \times 436) + (498) - (4 \times 464)$$

1370

1856

$$= -486 \text{ kJ/mol (exothermic)}$$

bond energy
values are
given



* **Fuel**: is a substance that can be burned to transfer thermal energy to surrounding

e.g. coal, natural gas (methane)
 CH_4 , petroleum

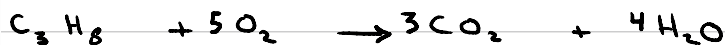
* **Combustion**: burning fuel (a hydrocarbon) with oxygen (exothermic reaction)

* **Hydrocarbons** are compounds contain hydrogen and carbon, sometimes oxygen.

→ **complete combustion**: when hydrocarbons burn in excess oxygen, produce CO_2 and H_2O

e.g. propane + oxygen → carbon dioxide + water

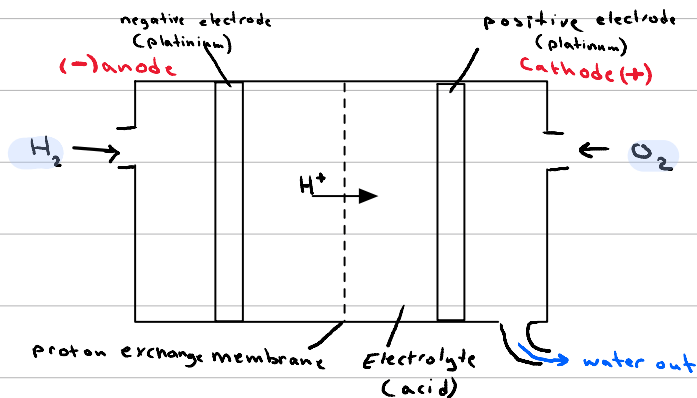
www.ck12.org



→ **Incomplete combustion**: when there is not enough oxygen to burn the fuel.

produce carbon monoxide (CO) and water as the main products, with some CO_2

Hydrogen - oxygen fuel cell : used to generate electricity and it produces only **water**.



Step 1 : supply H_2 to the anode and oxygen to cathode

Step 2 : H_2 is oxidised, it loses e^- at the anode and forms H^+

$$H_2 \rightarrow 2H^+ + 2e^-$$

Step 3 : electrons flow from anode to cathode at the external circuit producing electric current.

Step 4 : Oxygen gains electrons at the cathode and reacts

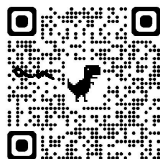
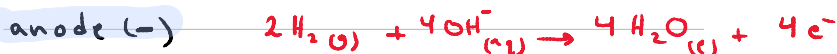
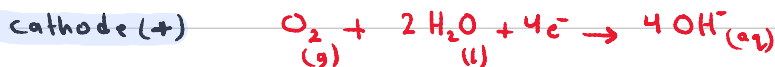
with H^+ from acid to form water $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

overall equation; $2H_2 + O_2 \rightarrow 2H_2O$

* proton exchange membrane allows H^+ to pass from negative to positive sides to replace the H^+ that is removed from acid electrolyte
→ so the concentration of electrolyte remains constant.

<https://aseelkhatib.com/chemistry-resources>

* another type of fuel cell uses alkaline electrolyte :



Fuel cell compared to gasoline engines

advantages

- * no pollution as water is the only product
- * transfer more energy than gasoline
- * silent engine
- * higher efficiency than gasoline engines
- * small size

disadvantages

- * more expensive (Platinum is very expensive)
- * hydrogen is expensive to produce
- * few hydrogen filling points at garages
- * hydrogen is extremely flammable and must be stored safely as a liquid.

<https://aseelalkhatib.com/chemistry-resources>

